Mercer has provided no documentation for these three modules (see AT&T's response to request 3.3).

The lack of model documentation further hampered my inspection. Each module is in the form of an Excel Workbook, each containing a minimum of eight individual worksheets. It took considerable time just to find the data inputs, much less determine the logic flow of the worksheet or validate any inputs.

Q. WHY DIDN'T YOU ASK FOR ASSISTANCE FROM HATFIELD ASSOCIATES PERSONNEL TO UNDERSTAND THE LOGIC AND ASSUMPTIONS USED IN THE HATFIELD COST MODEL?

A. None of the questions I asked concerning the working of the model, the model assumptions, and even the model cell references within the worksheets were answered. I was told by the AT&T attorney present that I was free to examine the models while I was there, but not to ask any questions.

Q. DO YOU FEEL THAT THE TYPE OF INSPECTION OFFERED TO YOU IS SUFFICIENT TO VALIDATE THE HATFIELD MODEL'S ASSUMPTIONS, INPUTS, ALGORITHMS, AND RESULTS?

A. Definitely not. Under this type of inspection regimen, it is impossible to even understand the manner in which the model works, much less validate the model results.

AT&T'S RESPONSES TO U S WEST DATA REQUESTS

Q. USW DATA REQUEST 3.4 ASKED IF THE HATFIELD MODEL INCLUDES ALL OF THE COSTS OF CONNECTING AN END USER TO THE NETWORK. AT&T RESPONDED THAT DR. MERCER'S STUDY ONLY EXCLUDED CUSTOMER INSTALLATION COSTS. DID THE DEVELOPERS OF THE BCM INCLUDE ALL THE NETWORK COSTS OF CONNECTING AN END USER TO THE NETWORK?

A. Definitely not. The Joint Sponsors have repeatedly stated that all network investments necessary to connect an end user to the network were not included in the BCM. For purposes of simplification, only the major cost drivers that help to identify and differentiate high cost areas from low cost areas were included in the BCM. In fact, on February 21, the Joint Sponsors filed a list of planned enhancements to the BCM with the FCC. The list states the improvements that the Joint Sponsors intend to make to the model to more closely follow actual engineering practices and how these changes correct BCM deficiencies.

Q. DID THE HATFIELD MODEL EXTENSIONS ADD THE INVESTMENTS THAT WERE NOT INCLUDED IN THE BCM?

A. No. The Hatfield model extensions only added drop wire and the network interface device (NID) and these two items were added at investment levels that are unquestionably low. Testimony in USWC's recent rate case indicates Utah costs at least three times the level Hatfield used. The Joint Sponsors have publicly stated that not only are the drop wire and NID not included in the BCM but that the investments in pedestals, serving area interfaces (SAI), terminal boxes, cross-connects in the field, as well as the capitalized costs of splicing and engineering are not included.

Q. ARE THERE ANY OTHER AREAS WHERE THE HATFIELD MODEL'S USE OF THE BCM CAUSES AN UNDERSTATEMENT OF LOOP COSTS?

A. Yes there are two other areas that lead to an understatement of loop costs. As I mentioned in my rebuttal testimony, urban distribution plant is understated because it assumes a constant four distribution legs per CBG. Generally, in urban areas, distribution plant legs run along the rear lot lines of houses, serving houses on either side of the lot lines with the drop wire. Any CBGs where there are more than

eight housing unit lots per side will have an understatement of the distribution plant because those houses cannot be reached directly with drop wire. This understatement will be corrected by the BCM enhancements under development.

The second item that causes an understatement of loop cost occurs when placement and structure costs are calculated using the BCM's weighted structure multiplier cost table with small cable sizes. This causes an understatement of investment because the decline in capitalized trench costs is not linear with the decline in per foot investment cost of copper cable as cable sizes decrease. Generally, the per-foot costs to dig a trench or plow a cable are not a function of cable size, but rather a function of surface and soil conditions (e.g. plowable soil in rural area or asphalt cut and restore in urban area). This understatement has been pointed out by GTE in the California Universal Service proceeding, as well as ETI in the FCC's proceeding.

Q. **DO YOU HAVE REASON TO BELIEVE DR. MERCER IS AWARE OF ANY OF THESE INVESTMENT ITEMS YOU MENTION THAT ARE NOT INCLUDED IN THE BCM?**

A. Yes. In the California Universal Service proceeding Dr. Mercer modified his Hatfield Cost Model in a presentation dated April 3, 1996 (See Exhibit 1) to include a single SAI for each CBG. Even though multiple SAIs are generally required in each CBG, at least he recognized in California that SAI investment was not included. Additionally, the Hatfield model adjusted the cost of digital loop carrier equipment upward from the $187 per line (this number is in their Utah model) to $219 per line. Other adjustments to the Hatfield model noted in this presentation are the addition of some pedestal and splicing costs and an additional $60 per line switch investment. I find it very disturbing that the Hatfield model recognizes these investment components as necessary for providing local service in California but not in Utah.

Q. **DR. MERCER CHANGED A NUMBER OF INPUTS TO THE BCM. WHAT ADDITIONAL DOCUMENTATION DOES HE PROVIDE FOR THE CHANGES IN HIS RESPONSES TO THE USW DATA REQUESTS?**

A. Based on U S WEST data requests 2 and 3, AT&T's stock response is that no documentation exists and that Hatfield Associates rely on conversations they have had over the years with various persons involved in telecommunications. This appears to be another way of

saying that an input change is based upon an educated guess and not first hand knowledge or a source that can be documented.

In areas where AT&T has supplied a back-up study, its value for determining costs in Utah is questionable. For instance, values that Dr. Mercer utilized from a New Hampshire incremental cost study were developed to study cost changes due to incremental growth in an existing network. The New Hampshire study is not a Total Service Long Run Incremental Cost Study, contrary to what Dr. Mercer states he has provided in this docket. Therefore, any numbers described from the New Hampshire study were not developed to produce total service cost, just the cost of a small increment of growth. Therefore, Dr. Mercer's use of that study is improper.

Q. **PLEASE SUMMARIZE YOUR TESTIMONY.**

A. AT&T has not submitted the Hatfield Cost Model to full public scrutiny. The lack of documentation of the Hatfield Cost Model is astounding. None of the Hatfield Cost Model modules has any module-specific documentation. More specifically, none of the algorithms or logic contained in the Excel workbooks are documented. Inputs and assumptions are the Hatfield

Associates "best guess". The "best guess" inputs all tend to understate the loop investment. Until the Hatfield Cost Model is fully documented on the public record, including documented sustainable inputs, it should not be considered in this proceeding.

Q. DOES THIS CONCLUDE YOUR TESTIMONY?

A. Yes it does.

Hatfield Proxy Model

Model Enhancements

HPM Model Revisions

Serving Area Interface

- *SAI added per CBG*
- *Drivers*
  - *Total Lines*
  - *Feeder Technology (i.e., fiber, copper)*
- *Investment Values = Best Estimate*

HPM Revisions

Digital Loop Carrier

- *NET New Hampshire Study*
  - *Assumes $170 per line*
  - *Plus $24 additional installation*
  - *Plus $25 per DSO (Wire Center Digital X-Connect per wire Center)*

HPM Revisions

Terminal and Splices

- *Terminal (pedestals) and cable splices added*
- *Adds $50 per line*

HPM Revisions

Wire Center Investment

- *Per switch or multiple switches*
- *Investment includes:*
  - *Switch room size*
  - *Land Investment*
  - *Construction Cost per sq. ft.*
  - *Power systems*
  - *Distribution frames*

HPM Revisions

Switch Investment:

- *$60 added per line*
- *At 80,000 lines Switch cost per line = $135*
- *Increased to reflect public sources.*

APPENDIX D

BEFORE THE PUBLIC SERVICE COMMISSION OF UTAH

* * * * *

IN THE MATTER OF THE REQUEST FOR AGENCY ACTION OF PHOENIX FIBERLINK OF UTAH, INC. FOR AUTHORITY TO PROVIDE INTRASTATE TELECOMMUNICATIONS SERVICES IN THE STATE OF UTAH,	)	DOCKET NO. 95-2206-01
IN THE MATTER OF THE APPLICATION OF ELECTRIC LIGHTWAVE, INC. FOR AUTHORITY TO COMPETE AS A TELECOMMUNICATIONS CORPORATION AND TO OFFER PUBLIC TELECOMMUNICATIONS SERVICES,	)	DOCKET NO. 94-2202-01
IN THE MATTER OF AN INVESTIGATION INTO CO-LOCATION AND EXPANDED INTERCONNECTION	)	DOCKET NO. 94-999-01
U S WEST COMMUNICATIONS (USWC) ADVICE LETTER 95-16	)	DOCKET NO. 95-049-T16

DIRECT TESTIMONY OF

ROBERT A. MERCER

ON BEHALF OF

AT&T COMMUNICATIONS

OF THE MOUNTAIN STATES, INC.

March 14, 1996

Q. PLEASE STATE YOUR NAME AND ADDRESS.

A. My name is Dr. Robert A. Mercer. My business address is Hatfield Associates, Inc., 737 29th Street, Suite 200, Boulder, Colorado 80303. I am the President of Hatfield Associates, Inc.

Q. PLEASE DESCRIBE YOUR EDUCATIONAL BACKGROUND.

A. I received a Bachelor of Science degree in Physics from Carnegie Institute of Technology (now Carnegie - Mellon University) in 1964, and a Ph.D. in Physics from Johns Hopkins University in 1969. I have attended numerous courses, seminars, and conferences in the field of telecommunications.

Q. PLEASE DESCRIBE YOUR PROFESSIONAL EXPERIENCE.

A. After graduation from Johns Hopkins, I was an Assistant Professor of Physics at Indiana University from 1970 until 1973. I then joined Bell Telephone Laboratories. Over the next eleven years, I held a variety of positions in the Network Planning organizations at Bell Labs and AT&T General Departments. My final position at Bell Labs was Director of the Network Architecture Planning Center, where I was responsible for early Bell System planning of the Integrated Services Digital Network (ISDN), as well as systems engineering for new data services being planned by AT&T.

Upon the AT&T divestiture, I joined Bell Communications Research (Bellcore) in January, 1984, where I was Assistant Vice President of Network Compatibility Planning. Among other responsibilities, I directed Bellcore's technology analysis of various legal and regulatory proceedings at the federal and state levels. I also coordinated and provided direction to Bellcore's activities in domestic and international standards activities, and

served as a member of the Board of Directors of the American National Standards Institute.

After leaving Bellcore in late 1985, I held positions with BDM Corporation and AT&T Bell Laboratories before joining Hatfield Associates, Inc., in early 1987. I have held the positions of Senior Consultant, Senior Vice President, and President of the firm. The firm specializes in engineering, economic, and policy studies in the telecommunications field. Our clients include firms involved in premises, local exchange, long-haul and international networks, satellite communications, cellular mobile radio, conventional mobile radio, cable television, and data and computer networking.

I also hold an adjunct faculty position in the Interdisciplinary Telecommunications Program at the University of Colorado in Boulder, where I currently teach a course on Advanced Data Communications and Computer Networking. I have taught many other courses and seminars as well, in the areas of the telecommunications infrastructure, network technologies, broadband networks, data and voice communications, computer networking, and network management.

Q. HAVE YOU TESTIFIED PREVIOUSLY?

A. Yes. In recent years, I have testified for AT&T, MCI, or both in Pennsylvania, Colorado, Washington, and Maryland, the Florida Cable Television Association, the Cable Television Association of Georgia, and, in Canada, for Unitel Communications, Inc. While an employee of Bell Telephone Laboratories and Bell Communications Research, I testified before state regulatory bodies on a number of occasions.

Q. WHAT IS THE PURPOSE OF THIS TESTIMONY?

A. I have been asked by AT&T to estimate the costs of the loops associated with basic local telephone service U S WEST provides in the state of Utah. I have determined these costs using a methodology which I will henceforth refer to as the Hatfield Model. The Hatfield Model has been developed to estimate the cost to a telephone company of providing basic local telephone service. As discussed herein, however, it can, with a small extension of the methodology, also be used to estimate the cost of just the local loop, one of the components of basic local service. The Hatfield Model incorporates portions of the Benchmark Cost Model, which is a model that was developed by MCI, Sprint, U S WEST, and NYNEX, and has been presented to the FCC in Common Carrier Docket 80-286.

Q. WHAT IS THE ULTIMATE OUTPUT OF THE HATFIELD MODEL WITH THIS EXTENSION?

A. It is the monthly cost per line of the local loop, based on capital investment per line, expense factors based primarily on USOA definitions, and capital cost and depreciation figures.

Q. PLEASE DEFINE WHAT YOU MEAN BY BASIC LOCAL TELEPHONE SERVICE.

A. Our definition of basic local telephone service for this study includes the following functional components:

* single-line, single-party telephone access to the first point of switching in a local exchange network -- that is, the so-called local loop;
* usage within a local exchange area;
* touch tone capability;

* a white pages directory listing; and
* access to 911 services, operator services, directory assistance, and telecommunications relay service for the hearing-impaired.

Excluded from this definition are many other local telephone company services, such as toll calling, interexchange carrier access, Custom Calling and CLASS^{SM} services, and private line services.

Q. THIS DEFINITION OBVIOUSLY INCLUDES MORE THAN JUST SIMPLY THE LOCAL LOOP. IS IT APPROPRIATE TO USE THE MODEL WHEN THE PRIMARY INTEREST IS THE COST OF THE LOCAL LOOP?

A. Actually, it is not only appropriate, it is necessary if the loop costs are to be properly estimated. This is because there are a number of expenses associated with local telephone service that cannot be directly identified with one portion of the local network, but are shared by all of them. The Hatfield Model estimates all such costs. With the extension to the model discussed later, it then identifies an appropriate portion of those costs with the local loop. This extension requires that the total investment in the local network and various expense components still be calculated. Were such costs not taken into account, the result would be that the loop costs would be underestimated.

Q. HOW DOES THE MODEL ESTIMATE THE COST OF BASIC LOCAL TELEPHONE SERVICE?

A. Attachment 1A (Exhibit RAM - 1A) depicts the process by which the Hatfield Model estimates the cost of basic local telephone service. The process involves a number of different modules. It begins with a local network module, which contains an engineering model of the local telephone network infrastructure that would be used to provide basic

local telephone service in the particular area being studied. There are several inputs to this module, key ones including the demographic attributes of the area being studied and capacity limits for the various network elements that make up the local network. The module determines the types and amounts of network equipment required to provide basic local telephone service in the area studied, including distribution (local loop) and local end-office switching. These outputs, along with the unit costs of various items of network equipment, become inputs to an investment module.

The investment module develops an estimate of the investment required for various types of network equipment. The outputs of the investment module are subsequently used in two ways. First, they are input to a capital cost module along with various capital cost parameters such as the cost of equity, cost of debt, debt to equity ratio, economic life of the network equipment, and the combined state and federal income tax rate. The capital cost module produces the monthly per-line capital carrying costs. Second, the network investment is also input into an expense module, along with various expense factors, as discussed subsequently. The expense module produces the monthly per-line Operations, Administration and Maintenance (OA&M) expenses.

The monthly capital carrying costs and the monthly expenses are then added to produce the key result, which is the estimated monthly cost per line of basic local service. This is essentially the final step of the process. As an alternative additional step, the model can compare the monthly cost per line and the monthly revenues to determine the amount of subsidy required for basic service, if any

Q. HOW DOES THE HATFIELD MODEL INCORPORATE THE BENCHMARK COST MODEL (BCM)?

A. The Hatfield Model makes use of the BCM in two ways. First, the BCM includes a database which assigns each Census Block Group (CBG) in the United States to a specific existing LEC wire center. Thus it is possible to estimate the number of lines served by, and therefore determine the size of the switches required at, each LEC wire center.

Second, the Hatfield Model uses the BCM to model the loop plant and compute loop investment associated with each CBG. From the input CBG data and another database that contains terrain data by CBG, BCM calculates the following for each CBG:

* *feeder and distribution cable distances and terrain factors*, which are input to the calculation of
* *amounts, and associated structure multipliers, of copper distribution cable, copper feeder cable, and fiber feeder cable*, which are input into the calculation of
* *total loop costs and costs per line*.

In making these calculations, BCM allows for the sharing of feeder cable between CBGs belonging to the same wire center, so it produces an accurate depiction of the distribution network associated with each wire center.

As a result of assigning each CBG, with its associated loop costs, to LEC wire centers, it is possible to disaggregate cost studies to the wire center level, while at the same time allowing aggregation to higher levels, such as by population density zone, telephone company operating territory, state, or the nation as a whole.

Q. **HOW DOES THE HATFIELD MODEL DIFFER FROM THE BCM?**

A. The Hatfield model uses the database and loop model contained in the BCM. But it adjusts certain BCM inputs that were intended to be varied by the user, and uses alternative mechanisms to deal with the investment in the parts of the network other than the loop plant and with the calculation of monthly costs. The relationship between the

Hatfield Model and the BCM that it incorporates is shown in Attachment 1B (Exhibit RAM-1B). The specific changes we have made to the BCM inputs, along with other differences between the BCM approach and the Hatfield extensions to BCM are as follows.

First, the Hatfield Model accounts for business lines and multiple-line residences in the loop plant, which have been excluded from the loop facilities calculation in the BCM. We have modified the BCM input data to account for business lines and multi-line residences by density range. We select numbers per range to make the final access line totals equivalent to those shown in the Common Carrier Statistics. The result is to size the loop plant to accommodate business and multi-line residences, which is not done by the BCM.

Second, we use significantly lower investments per line in Digital Loop Carrier (DLC) equipment than the BCM default numbers indicate. Our numbers are based on private conversations we have had over the years with LEC staff involved in DLC procurement, and with manufacturers.

Third, unlike BCM, which makes an overall calculation of monthly costs using a single fixed multiplier to estimate expenses and capital carrying costs associated with the total investment in the distribution network, we use the intermediate BCM results to break the loop investment into categories for applying expense factors based on FCC ARMIS reports, and to compute capital carrying costs for the network investment. This allows us to vary economic life, debt/equity ratio, cost of capital, and other financial factors to gauge their effects on the overall monthly cost results. We treat other network components in the same fashion.

Fourth, the BCM does not compute investment for customer drops or network interface devices. The Hatfield Model as applied to Utah includes both these items. It

assumes a uniform $40 per-line drop investment, as estimated by New England Telephone in a publicly available incremental cost study, and an investment of $30 per line for a network interface device. The latter figure is based upon discussions with other industry experts.

Finally, we believe that the default line fill factors assumed by the BCM are too low -- for instance, only 25% in areas of low population density. This tends to lead to cost results that are too high due to the excess amount of outside plant required to serve a given number of customers. We have therefore assumed fill factors that begin at 50% in the lowest density range and end at 75% in the highest range, as shown in Attachment 2A (Exhibit RAM-2A).

Q. HOW HAVE YOU DETERMINED THE INVESTMENT IN SWITCHING?

A. As I discussed above, we use intermediate BCM results as inputs to our switching, investment, and expense models. We apply the modified BCM switched access line totals to a two-segment linear switch investment model to produce a per-line switching investment. The switch investment model includes a multiplier for wire center investment and switch installation costs as well as maximum switch fill. Based on the switching system capacity limits and the number of lines served by each wire center, the model calculates the number of switches required to serve each wire center and also determines the size and cost of those switches.

Q. DOES THE MODEL ESTIMATE THE AMOUNT OF INTEROFFICE FACILITIES REQUIRED?

A. Yes. Because the BCM does not provide the information necessary to determine the location of tandem switches or the way in which the various wire centers are

interconnected, we have added LATA-specific data containing geographical switch locations. This also allows us to locate tandem switches as well as Signaling System 7 Signal Transfer Points (STPs) in relation to the physical location of the end-office switches serving the switched access lines in the model. Knowing the physical locations of the various switching entities makes possible the determination of interoffice transmission investment, as well as investment in STPs and tandem switches.

Q. WHAT IS THE BASIS FOR THE STRUCTURAL ASSUMPTIONS USED IN THE MODEL?

A. The overall network structure is typical of a LEC's network using forward-looking technologies, as described in various references, including Bellcore's *BOC Notes on the LEC Networks*. Thus the engineering model we use is consistent with standard LEC network engineering practices.

Q. HOW DID YOU ARRIVE AT THE VARIOUS CAPACITY ASSUMPTIONS USED IN THE MODEL?

A. The digital loop carrier equipment capacities and cable capacities for both optical and copper facilities used by the BCM are based on systems that are widely used by LECs, on various industry publications, including those by Bellcore and AT&T, on FCC reports, on the knowledge of industry experts who helped develop the model, and on the BCM inputs. Switching system capacity assumptions result from discussions with various industry sources and an examination of the FCC's *Statistics of Common Carriers*.

Q. HOW DID YOU DEVELOP YOUR INVESTMENT ASSUMPTIONS?

A. Equipment costs were derived from discussions with equipment manufacturers, published price lists, and cost figures disclosed in various public proceedings such as in FCC pleadings. For the distribution network, we used the default assumptions of BCM, except for the cost of DLC systems, as mentioned earlier. We developed switch installation costs from discussions with industry experts directly involved in installation and equipment procurement.

Q. HAVING CALCULATED CAPITAL INVESTMENT, HOW DO YOU DETERMINE THE RECURRING MONTHLY COSTS OF BASIC LOCAL TELEPHONE SERVICE?

A. The recurring costs are based on the investment figures generated by the investment module. The recurring cost module has three steps. First, it determines the capital carrying cost for each component of investment associated with the network function. Second, it determines the network-related expenses associated with each component of investment. Finally, it determines non-network-related expenses, and assigns the expenses to the network functions.

Q. WHAT ARE CAPITAL CARRYING COSTS?

A. Capital carrying costs consist of depreciation expenses, the cost of capital (return and interest), and state and federal income taxes.

Q. HOW IS DEPRECIATION EXPENSE DETERMINED?